THURSDAY, DECEMBER 3, 1891.

## *FIELD GEOLOGY.*

*Outlines of Field Geology.* By Sir Archibald Geikie, F.R.S. (London: Macmillan and Co., 1891.)

GEOLOGISTS, we are sometimes told, are a combative race. Geologists may fearlessly allow that the impeachment has a spice of truth in it. They may take comfort when they reflect that no serious consequences have ever followed from this tendency, in spite of the facilities which the formidable weapons they carry with them offer for pushing it to an extreme. Their healthy out-door life prompts banter, and the passes are apt to be so quick and keen that the uninitiated may be pardoned if they think the buttons are off the foils.

The meetings of the Geological Society have witnessed many a sharp passage of arms. It may be permissible to recall one. A well-known member of the brotherhood, safe long ago among the majority, of large and varied experience, was indulging in just a little brag about the broad areas he had surveyed. The retort came sharp and quick from one whose quips and cranks are now alas heard no more: "Where are your maps?" And the contemptuous answer was, that the chief requisites for geological mapping were a stout pair of legs and sound wind. There were elements of truth in this lively sparring, despite its extravagance.

It is a truism that need hardly be repeated, that geology cannot be learned without out-door work, and geological excursions are a necessary item in all geological teaching. But what do they amount to? There is a leader who knows the country well. He selects a line along which sections follow one another in close succession. The exposures are so plentiful and near together that even the beginner realizes without difficulty the order in which the several rock-groups follow one above the other, and there are ample opportunities for mastering their lithological character and fossil contents. A longitudinal section is readily constructed, and figures with more or less of misconception in the note-book of each of the party. An admirable start this. But what is it compared with the mental discipline that goes along with the making ot a geological map, and the grip of the subject that results from this form of geological work? There is as much difference between the two as between that form of sport which consists in riding behind a pack of hounds who follow a trailed herring, and the stalking of deer in their native wilds.

It is in mapping more than in any of its other branches that geology rises to the level of an educational tool. Here there must be the instinctive skill, acquired by long practice, which leads the surveyor to select in his preliminary work the traverses most likely to give a broad view of the structure of the district he is working over; the patience which forbids, when the first rough sketch comes to be filled in, that a single square yard of ground shall be left unvisited, lest some bit of evidence should be missed; and the constructive power which pieces together the accumulated mass of multifarious data into a consistent whole. Keenness of eye, neatness of hand, judgment, unwearied application, and chastened imagination figure among the requisites for the work, and grow in strength as it proceeds. Surely the finishing touch in a geologist's education is given by the making of a geological map.

That the art cannot be learned from books alone, goes without saying; that books can do but little towards teaching it, may be safely maintained. But there is no reason why a master should not give us in print all the aid that a book can afford, and lure us to the fascinating pursuit by an eloquent description of its charms. And that a book which deals with field-geology has been found of service, and that geologists are not averse to hear the praises of their favourite employment, are proved by the fact that the little book on this subject by the Director-General of the Geological Survey is now in its fourth edition.

The work is primarily addressed to geologists, but it appeals also to those who have no claim to so distinctive a title, and no wish for it. It shows how much pleasure may be derived from an acquaintance with the science no larger than any intelligent person may easily acquire; how even this moderate amount of knowledge enhances the enjoyment of travel and of the daily walk. But let the author speak for himself.

> "To those who are fond of country rambles geology offers many attractions. Few men are so unobservant as not to be struck, now and then, by at least the more salient features of a landscape. Even in a flat, featureless country, the endless and apparently capricious curvings of the sluggish streams may occasionally suggest the question why such serpentine courses should ever have been chosen. But when the ground rises into undulations, and breaks out into hills or crags; still more, when it towers into rugged mountains, cleft by precipices down which the torrents are ever pouring, and by ravines in the depths of which the hoarse streams ceaselessly murmur, one can hardly escape the natural curiosity to know something about these singular aspects of the landscape, when and how they arose, and why they should be precisely as they are."

Our author goes on to say that "the day is now happily past when the sterner features of the land awakened only a feeling of horror; when they were styled hideous and unsightly; when they were never visited save under the necessities of travel, and were always left behind with a sense of relief." That the appreciation of the beauty of mountain scenery is a taste of modern growth can hardly be disputed. It is open to question whether the comforts of modern travel have not done as much to foster it, as a scientific curiosity to know how the forms which charm our eye were produced. But, however this may be, the awakening and the satisfying of such curiosity are added items to the stock of pleasures which the lover of Nature derives from her wilder aspects.

Some of the inducements to field-work having been thus attractively put forward, the author defines the aim of the book. The student

> "must betake himself to Nature from the first. His lessons in the field should accompany his lessons from the text-book or lecture-room. In many cases he must grope his way without guide or assistance. . . . The following chapters are offered for his help. . . . Their aim is to point out how observations may be made, what kinds of data should be looked for, what sort of evidence should be sought to establish a conclusion, and

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what deductions may be drawn from particular facts. In short, they are to be regarded as sign-posts pointing out some of the highways and byways of geological inquiry, but leaving the reader to perform the journey in his own fashion."

At the outset it is made clear that, though some localities supply more material than others, even the most unpromising are far from barren of interest to those who have eyes to see. The necessary equipment is fully described. In addition to the "cheese-taster" mentioned on p. 29, the portable boring-apparatus devised by Belgian geologists has been found useful. So much stress has been already laid on the value of mapping, that it will be enough to say that, in the author's opinion, the geologist "acquires by it a thoroughness of grasp attainable in no other way." It would have been well if the meaning of contour lines, and the way in which hill-shading is used to denote the shape of the surface, had been treated of more fully. The illustrations of the sinuosities of outcrop across uneven ground, on p. 101, are beautifully distinct, but nothing is said as to the value of models in making clear this point to the beginner. Of course they tell most when he makes them himself: a little modelling clay can generally be obtained; but, in default of better material, an apple or turnip can be made to do good service. In the very handy approximate rule, on p. 116, for determining the thickness of a bed when its dip and the breadth of its outcrop are known, it is not stated that the surface on which the breadth is measured must be horizontal; or, if it be an inclined plane, we must substitute for dip the sum or difference, as the case may be, of the dip of the bed and the inclination of the plane to the horizon. The error committed in using this rule for a dip of 5° is a little over 4 per cent. in defect; it decreases as the dip increases up to 30°: for that angle the rule is accurately true. For dips over 30° the rule gives the thicknesses too great; the error increases rather rapidly with the dip, and at 45° amounts to 6 per cent.; for a dip of 50° it is nearly 9 per cent.

The great value of the book consists in this: from beginning to end it embodies the experiences of one who has spent a lifetime in field-work, and so it is full of "wrinkles" which could not possibly have been picked up in any other way. Most of these anyone who has in him the making of a field-geologist would sooner or later have found out for himself; but it is no small gain to the beginner to be put on the right track to start with, and to have his instructions conveyed with the life and freshness that practical acquaintance can alone give. The present writer feels proud that in one respect he can claim even a more extended experience than the author of the book: the latter, apparently, has never been suspected of being an incendiary (see p. 20), a fate which once befell him who pens this notice.

A. H. GREEN.

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## THE LAND OF THE LAMAS.

*The Land of the Lamas: Notes of a Journey through China, Mongolia, and Tibet.* By William Woodville Rockhill. With Maps and Illustrations. (London: Longmans, Green, and Co., 1891.)

MR. ROCKHILL has for so long a time taken special interest in Tibet that he is able to speak of it as his "life hobby." Accordingly, when, in 1884, he was attached to the U.S. Legation at Peking, he looked forward with pleasure to the chance of exploring the country; and he began to make the best of all preparations for the undertaking by studying the Tibetan language. At this he worked for four years, during which he also gave some time to the study of Chinese.

In the winter of 1888 he resigned his post of Secretary of Legation, and made ready for his long-anticipated journey. He determined to enter Tibet from the north, and started from Peking on December 17. The choice of this route made it necessary for him to make in the first instance for Lan-chou, the capital of the province of Kan-su; so he arranged with a cart firm to supply him with two carts, with two mules to each, to take him there in thirty-four days. For every day over this they were to pay him two taels, he giving them the same amount for every day gained on the date agreed upon. This plan worked admirably, and he reached his destination two days ahead of time. The distance was 1350 miles.

From Lan-chou, Mr. Rockhill advanced to Hsi-ning, the residence of the Chinese Imperial Controller-general of the Koko-nor, an official known to the Tibetans and Mongols as the Amban. As this magnate was strongly opposed to foreigners, Mr. Rockhill made off from Hsi-ning as soon as possible, going to Lusar, a village near Kumbum. Kumbum is a great religious centre, and he was fortunate enough to be present on the 12th of the first moon, when the Chinese in every village and town of the empire celebrate the dragon festival. After looking through one of the temples, he and those who accompanied him walked round it, keeping it on the right hand—"a mode of showing respect for sacred things observed in all lamaist countries." At a lamasery in the neighbourhood, where he found a native who had taught him Tibetan at Peking, he had much pleasant talk with various lamas. These authorities were, he says, "immensely amused" by what he had to tell them about esoteric Buddhism and the Mahatmas.

Mr. Rockhill's final preparations were made at Tankar, the most westerly border town in that part of Kan-su. From this place, with his men, he set out on March 24, 1889, and was soon across the frontier. His intention was to visit Lh'asa; and had he succeeded in carrying out this plan, his narrative would probably have taken rank among the foremost modern books of travel. Unfortunately, the difficulties in the way proved to be insuperable, and he was obliged to content himself with a much less ambitious enterprise. The first country traversed by the party was Koko-nor, their route taking them past the northern shore of the great lake from which the region derives its name. This lake is some 230 miles in circumference, and its altitude is about 10,900 feet above sea-level. Looking at it from a low pass to the north-east, Mr. Rockhill describes it as "a glistening sheet of ice, stretching as far as the eye could reach to the west, and bounded to the south by a range of high, bleak mountains with snow-tipped peaks." To the north and west of the lake there is fine grazing-land, which is watered by many streams. Here nomads find excellent camping grounds in swales and hollows, which afford protection from violent west and north-west winds.

After leaving Koko-nor, the party passed in a southerly direction through Ts'aidam, crossing the Timurté

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